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ABSTRACT

For the purposes of bringing the processes of nature into the classroom so students can have direct, personal contact with them, this booklet presents examples of teaching tools useful in a general approach to environmental education. It does not deal with what should be taught about man and his environment, nor does it suggest how teachers should teach. Its purpose is to describe ways to build miniature environments for living things, using low cost materials and equipment. Through construction of aquaria and terraria the miniature environments for the living worlds of land and water are developed. Well detailed as to the background, construction, content, and use of such enclosed environments, the booklet continuously emphasizes the basic elements and processes of nature which are vital to all ecosystems. (BL)

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MINIATURE ENVIRONMENTS

AN ENVIRONMENTAL EDUCATION guidebook

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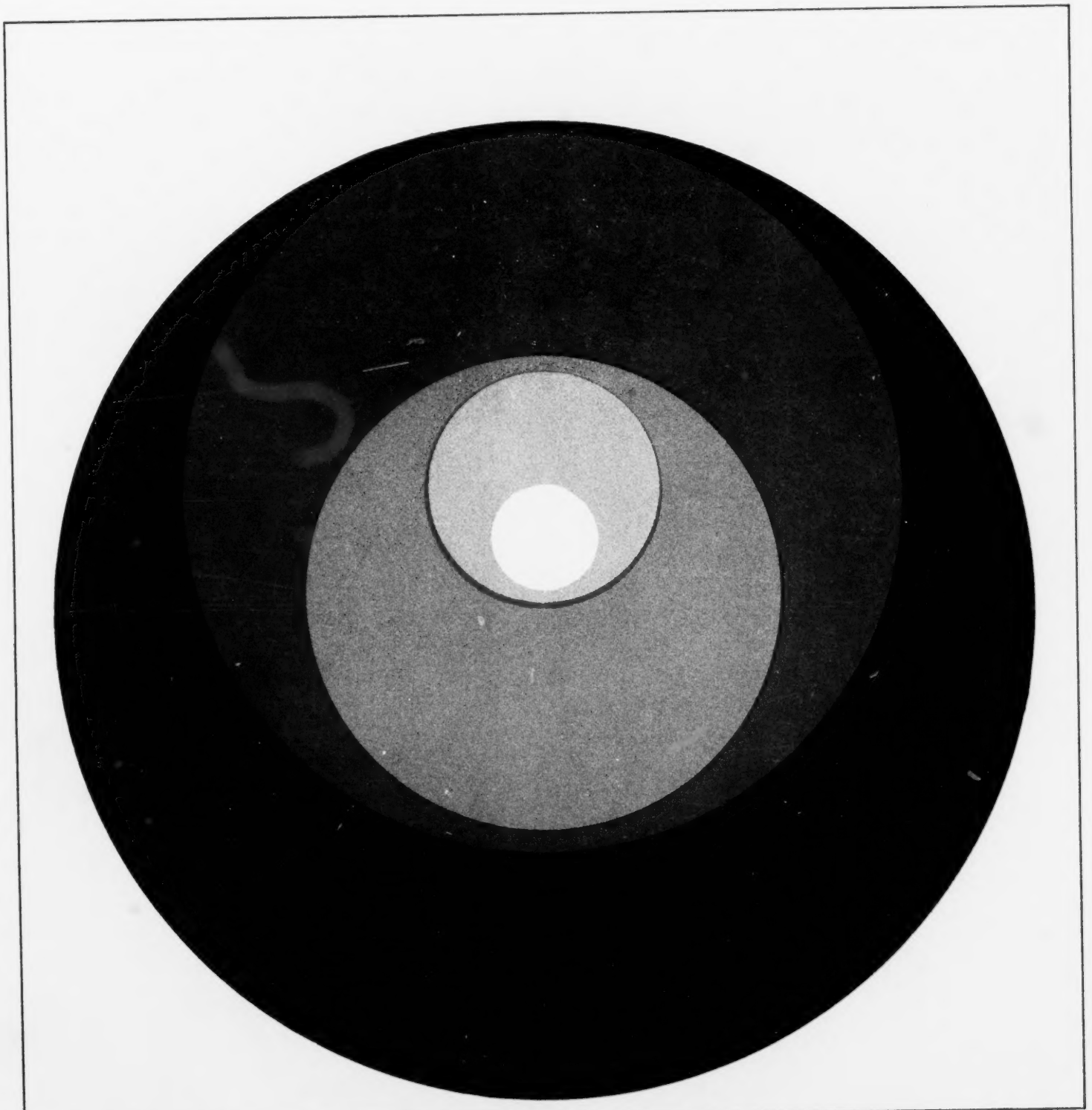

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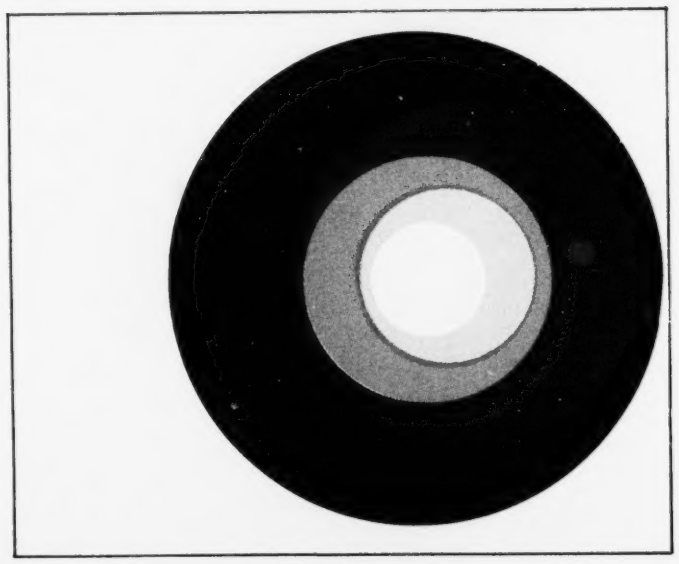
FOREWORD

Of all the imperative educational needs of our time, few are more important than the task of educating our children about the environmental and ecological principles that govern man's life on this planet.

To do this effectively, we must bring our children into closer contact with the natural environment. They must have opportunities to visit nature in an outdoor setting. But, equally important, the natural environment must be brought into their daily lives—at home and in the classroom. Through personal contact they will learn how nature functions, and come to appreciate the role these functions play in their lives.

This booklet deals with bringing nature into the daily lives of children. Its purpose will be achieved if it provides the means for children and teachers to enliven and enrich their study of the world which all living things share.



TO LIVE IN HARMONY WITH THE ENVIRONMENT, WE MUST UNDERSTAND ITS NEEDS

Environmental quality is very much on the minds of Americans today. We are concerned about pollution of air, land and water. We have built a world which is comfortable and convenient for ourselves, but in doing so we have exacted a heavy price from the natural environment. We have used up some resources that are limited and cannot be replaced. We have spoiled some resources that are necessary to support the lives of plants and animals. We are even destroying some resources that are essential for man's own life on this earth.

We are witnessing the awakening of genuine concern for the future of America, and we have cause to be concerned.

Out of our concern has come a realization that man and nature must live together in greater harmony. Both are part of the web of life; and any change in one aspect of this web creates yet more changes in other aspects. When changes are made thoughtlessly, the results may be far-reaching and serious. When such changes are not only thoughtless, but selfish and destructive to irreplaceable resources, man threatens himself as well as all the rest of his natural world.

With our newly awakened concern has come another realization—that our increasingly complex and powerful technology need not become the means of making our modern urban civilization unbearable. It can be used to help nature restore itself, and maintain the vital balance of environmental forces and processes which alone can support life and guarantee its quality.

Our determination to restore this needed harmony will be the deciding factor. Creating a national attitude of skillful and sensitive stewardship for the environment is a task which goes beyond today's dedication of energy to clean up pollution where we see it around us. It calls for all Americans, young and old, to understand their environment, and consider the consequences of what they do in terms of its effect on the environment.

This is a task for environmental education. "Environmental education" starts with environmental awareness, but it is more than merely teaching young people to recognize and classify plants and animals, and know their habits. Environmental education may be thought of as a process of recognizing and understanding the values and processes of the natural world, and the relationship of man and his culture to those values and processes. Ultimately, environmental education prepares people for sound decision-making about issues concerning environmental quality.

Broadening modern education to foster this understanding of environmental needs and new attitudes of environmental stewardship is difficult for two reasons: there is precious little curriculum space and time left to devote to new subjects; and, for three-quarters of our school population living in urban areas, there is little chance to learn about the environment in nature's best classrooms—the outdoors.

Fortunately, it is now possible and practical to bring the processes of nature into the classroom to an extent that can give students direct personal contact with them as part of their classroom experience. This booklet presents examples of teaching tools for bringing this new approach to environmental education into educational curricula.

NEW TOOLS FOR TEACHING

This booklet does not deal with **what** should be taught about man and his environment, nor does it suggest **how** teachers should teach. Its purpose is to describe ways to build miniature environments for living things, using low cost materials and equipment which, in many instances, have not previously been used for educational aids. It

is intended to excite imagination by presenting techniques which are versatile in their application to almost any environmental education need which calls for contact with the biophysical world. Students and teachers working together will find and develop new ways of using these tools as they become familiar with them.

The important thing they show is that nature and the workings of the environment can become part of the everyday personal experience of young people. Nature need not be something at the end of a bus ride—to be visited briefly and then left behind when the student returns to the classroom.

ECOLOGY—THE ENVIRONMENTAL VIEWPOINT

The purpose of creating miniature environments is to show how nature provides very specific conditions required to support various forms of plant and animal life, and, how the processes of nature renew these elements so that each form of life is sustained healthy and content. The sum total of the relationship of all these elements and processes is known as an **ecosystem.** The study of ecosystems is called **ecology.**

For educators, ecology is more than a body of facts about nature. It is a viewpoint which sees and relates the reactions of one facet of living and physical world to all others, and recognizes that there is a basic sense of order in the workings of natural processes in the environment. Through ecology, students learn how the various ecosystems of nature exist and thrive together in the environment. Through ecology, students learn how the ecosystems of nature are kept in balance, and are encouraged to apply the ecological viewpoint to all aspects of their education.

LIVING WORLDS OF LAND AND WATER

Miniature environments introduce students to the basic elements and processes of nature which are vital to all ecosystems. They show the necessity for proper temperature and humidity, and the importance of proper light for plant growth and stimulation of animal behavior. They permit observation of the behavior of plants and animals under normal natural conditions. By introducing man-made changes in the combination of air, water and land, they enable students to watch the processes of nature react, and to see how nature's self-correcting mechanisms restore balance to the environment. Daily observation of these environmental processes over long periods of time give students an appreciation of ecosystem needs and interactions.

In this way, miniature environments become living laboratories where students may discover by personal contact the workings of such diverse environments as deserts, tropical rain-forests, marshlands, and the various microclimates of the forest floor.

WATER ENVIRONMENTS

The art of keeping living things healthy in a water environment is an ancient one. Today the aquarium hobby enjoys great popularity, and a wide range of equipment and materials permit one to reproduce the environmental requirements for most varieties of aquatic life. Table-top tanks or floor-size ponds can duplicate natural environments for such pond life as turtles, bluegills, crayfish, and various types of floating vegetation which are part of their life-support system.

In a natural outdoor setting, the environment provides its own means for keeping water clean and furnishing sunlight for plant growth and the warmth needed by wildlife. In the miniature environments, these necessary elements are provided by lamps and combinations of pumps and filters. The water filtering facilities are in reality simple sewage treatment systems. Although not as refined as a municipal sewage disposal plant, the mechanical and natural organic mechanisms

employed by the pumps and filters utilize the same processes, and illustrate for the student the basic principles of nature's methods of controlling water pollution in outdoor environment.

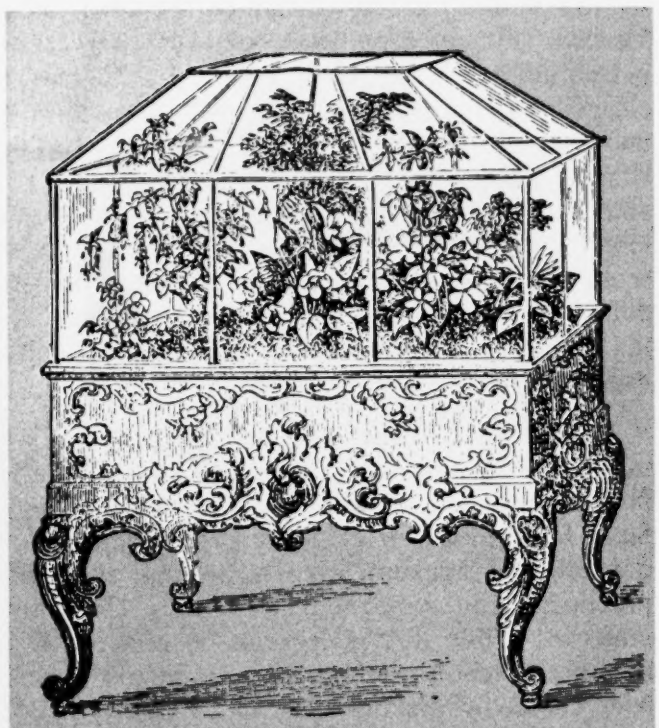
Practically all life-support requirements can be provided by using standard aquarium products and materials easily obtainable from commercial supply sources and hardware stores. Special fluorescent lamps, originally developed by industry for plant growing, can provide substitute sunlight for both plant and wildlife. Regular incandescent lamps provide the warmth element of sunlight which many forms of wildlife particularly enjoy and require. In the classroom, these substitute environments can be made as large or as small as desired for space and teaching needs.

LAND ENVIRONMENTS

Terrariums can be used to provide the basic shell for miniature environments in which animal and plant life live in a healthy simulated natural ecosystem. Specially-designed terrariums for the classroom may be adapted to the particular requirements of the life forms each contains. Requirements relating to temperature, humidity, light, and seclusion for animal life are given particular consideration.

Terrariums may be built with a common structural design which includes raised floor, angle-aluminum corners, siding to enclose an arena-like chamber, and some form of tenting to provide an enclosed area that can be kept warm and humid. In the case of open-topped arenas, a portion of the overall area can be enclosed to provide the animal life a choice between the two "climates" which the arena provides. This duplicates the animals' natural world where rocks and foliage provide differing climates within the animals' environment.

In the terrarium this two-climate arrangement is provided by having a part of each arena include a chamber enclosed by glass on three sides and



One ancestor of the modern terrarium was the parlor fernery found in the homes of many nineteenth century Americans. One style of fernery was an enclosed case which contained a complete micro-environment for the plants inside. Designed by an Englishman, named Ward, it won prizes at world fairs, and was copied as elaborately carved pieces of furniture. Ward discovered that plants could thrive in completely enclosed and sealed micro-environments when he noticed that a plot of earth which accidentally had been left in a sealed bottle began to grow. As he watched the bottle, he saw grass, ferns mosses and insect life appear and thrive in this enclosed world.

the top, with a hanging curtain on the fourth side. Vertical slits cut at various points in the curtain permit animals to push through the curtain, which closes behind them. Inside the chamber, warmth and humidity can be provided by a small lamp shining through the glass cover of the chamber, and causing water in a watering dish to evaporate into the enclosed atmosphere. This chamber presents a contrast to the cooler, drier atmosphere outside, just as the outdoor environment provides the climate contrasts needed in the natural ecosystem this represents.

A larger totally-enclosed terrarium, using the same basic structure, may use thin, tough plastic film in screen frames instead of glass sidings. Since large pieces of glass are costly, heavy, and dangerous if broken, large terrariums are more practical when constructed of sturdy clear film material. While this siding can be punctured, it is easily patched or replaced with new film in a wide choice of thickness.

Other large terrariums may provide a totally-enclosed warm, humid environment and a small filtered pond. Together these features provide an ideal environment for certain tropical or warm-climate reptile life. Fluorescent lights promote plant growth, which in turn tends to enhance the cleanliness of the arena as soil and plant growth partially handle the reprocessing of animal droppings.

WORLDS UNDER A DOME

The terrariums described so far share one thing in common: They are, entirely or in part, virtually sealed "worlds" in which the only element that needs to be continually added from the outside is light—the energy source that perpetuates life in these small ecosystems While these enclosed worlds can be opened for closer inspection (especially during times when inside condensation is severe) and plant trimmings, they can be left for weeks to care for themselves.

Being closed, moisture is contained in the terrarium, and the water-cycle of nature functions normally. Mosses and various swampland vegetation thrive in the warm humid climate which is provided. Direct sunlight is not necessary, and, indeed, is to be avoided, since it can overheat the enclosed areas. Normal window lighting is sufficient to keep plant life healthy. Located on a "lazy susan" turntable, they are easily rotated daily to make sure all areas inside are evenly exposed to window illumination.

These miniature worlds are limited in size only by the choice of the overall containers. Commercial sources offer a wide range of equipment that can be used. Even a simple clear plastic drinking cup turned upside down can become the container for a miniature ecosystem. Other domes range from cake covers and other kitchen containers to simple acetate cylinders from round container covers.

Inside the container, tiers for plantings can be fashioned from old tape spools and other plastic scrap. In the larger display, slabs of rock stuck together with silastic rubber cement can form natural-looking mounds and shelves on which to place mosses and other plants with a small portion of the earth they came from.

Where bodies of water—even in relatively small containers—are provided in the miniature worlds, a variety of minute wildlife can live in health and contentment. Some snails and perhaps a small fish can find enough food to live on in a water bath. Salamanders—seldom seen since they are very secretive—seek out niches in the natural habitats provided by the rocks and moss banks. When these enclosed ecosystems are assembled in the fall and winter, the soil and mosses which are placed in the domed enclosure contain many eggs of insects. Once in the warm indoor setting, this insect life hatches and enhances the activity taking place in the enclosed world.

Special plant-growing artificial lights may be

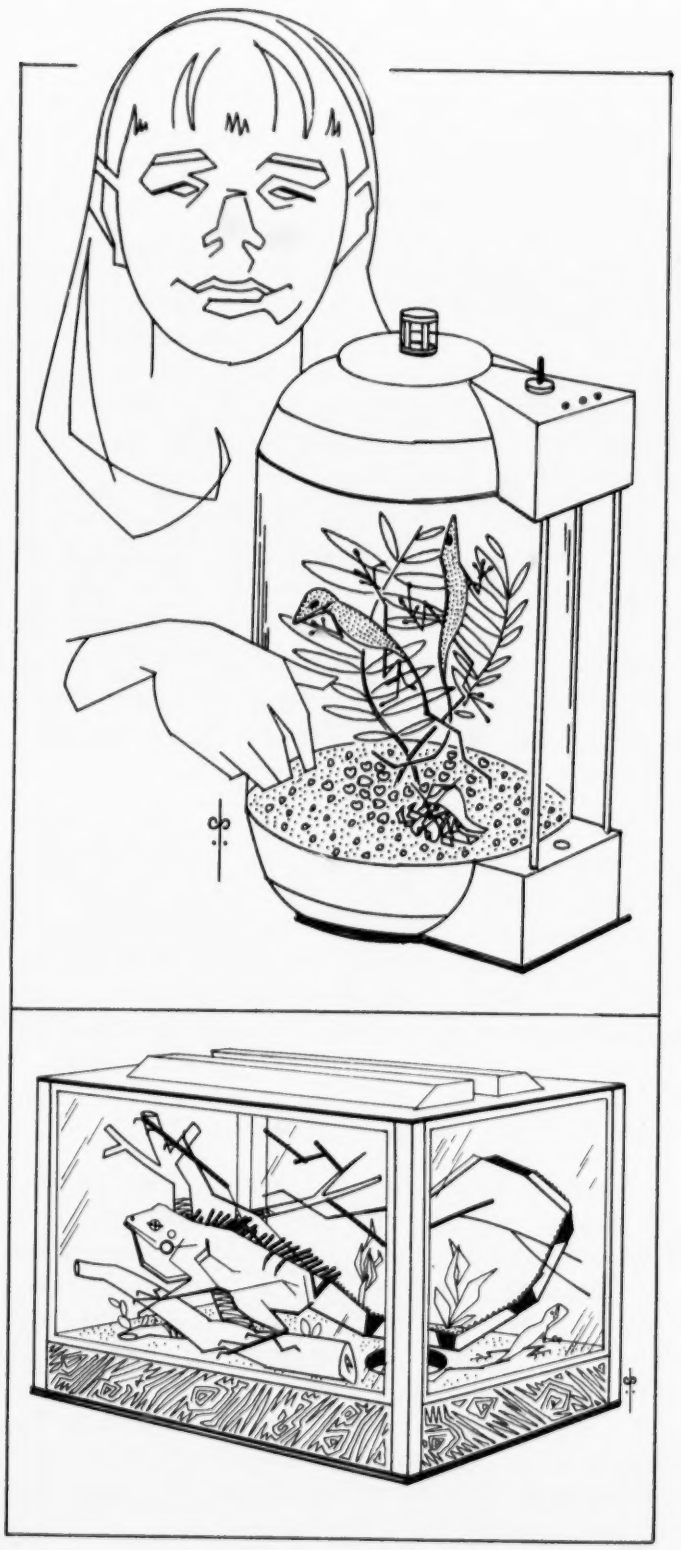
used in equipping miniature environments. A number of manufacturers now regularly make these special fluorescent tubes which provide the special light which photosynthesis and chlorophyl functions require to provide plant growth.

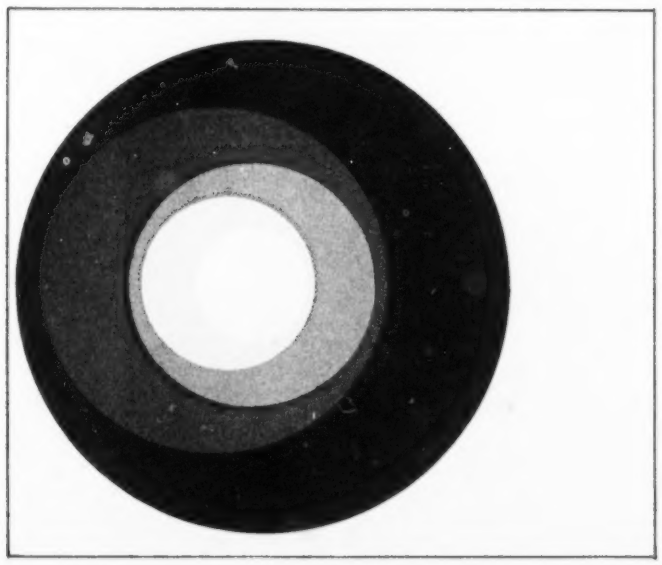
MINIATURE ENVIRONMENTS IN THE CLASSROOM

It is possible to design and build a wide variety of miniature environments which contain all of the elements needed for keeping living things in a soundly balanced ecosystem. At low cost, often using materials and equipment which has been developed for other primary industrial uses, teachers and students can create natural worlds-under-a-dome. Through these tools for teaching and interpretation, new dimensions can be added to the classroom experience of young people with the facets and processes of their environment.

The educational applications of these tools are broad and flexible. They can serve the goals of early school years for initial exposure and appreciation of the natural world. Equally well, they can provide a means for advanced instruction in the processes of plant and wildlife behavior, or the problems of pollution. They offer opportunities for first-hand experience with a wide range of environments—deserts, marshlands, forests, prairies, and ponds. The students' experience can be a daily event, carried on over long periods of time during which growth and change may be studied. Teamwork is important.

In the years ahead, when all Americans will be called on to act as stewards of the land, air, water and wildlife which comprise our great national heritage, and the vital elements which determine the quality of our life, these tools will be at the service of educators. Used imaginatively, these tools can assure that no American child, even in the crowded centers of our great cities, need grow up without an understanding and appreciation of the workings of the environment in which he lives.





ENCLOSED ENVIRONMENT FOR WARM CLIMATE PLANT AND ANIMAL LIFE

Great variety of plant and animal life lives in tropical or subtropical climates. Many classrooms, particularly in northern areas, have colder and drier climates than that to which such life is accustomed. When tropical or subtropical plants and animals are brought indoors, therefore, a warm and moist environment must be provided for them. For this it is necessary to build an enclosure that duplicates these natural conditions, but avoids the problems of excessive rot and fungus which typify hot, wet environments. The enclosure accomplishes these purposes.

This enclosure consists of a raised-floor picture-frame base, to which one inch angle-aluminum strips are attached at each corner and hold four "screen frame" sides in place. The side frames in this assembly utilize a clear thin plastic film to confine the warm humid atmosphere required by the plant and animal life enclosed. Glass is not recommended for such large containers because of cost and safety considerations.

The frame for each side is fashioned from aluminum screen frame material that is available at most hardware stores. While these frames are intended to use wire or plastic screen, they may be fitted instead with 2 mil-thick DuPont Surlyn 1601-A "Blister pack" film. This low-cost, tough, puncture-resisting material is able to stand the rigors that fingers and claws will inflict upon it from both inside and outside when used as an enclosure for a warm environment display.

Since plant-growing fluorescent lights are used to provide warmth and promote plant health in this environment, the top is made of one-quarter inch braced plywood. Standard aquarium lamp housings can be used to provide this light, and holes are cut into the plywood top in which to nest one or two such lamp housings. If desired, fluorescent lamps may be used. All necessary fittings may be obtained from a hardware store, and the fixtures may be mounted on the underside of the plywood top.

While the plywood top serves to hold the four side frames in place, masking tape with adhesive on both sides can be used to strengthen three of the plastic film screen frames in place. The remaining end frame is left untaped so it is easily slid up and out of the enclosure to permit cleaning. The side frames which abut this sliding frame must be measured carefully before assembly so that they provide a grooved slot to accommodate this sliding frame. And the plywood top must be cut short at the end so it allows free clearance for this frame as it is slid in and out of place.

The raised picture-frame floor serves several purposes. It provides a firm mount for the vertical aluminum frame pieces attached at each corner to hold the enclosure's screen frames in place. It also provides subfloor space in which water and feeding dishes, plant pots, and sand trays can be recessed and perhaps most important, a floor that is free of chill—which can be hard on turtles, lizards, etc. Where added floor warmth may be needed a small lamp of sufficient wattage can be wired under the floor to provide floor temperature to meet any need. Because considerable moisture is contained in the atmosphere of this enclosure, marine plywood should be used for the floor and top of this enclosure. Whatever wood is used, it should be thoroughly treated with a water resistant finish.

The picture-frame base should be about four inches deep to provide a firm mounting for the vertical one-inch aluminum side frame supports. These supports should be screwed into place so that they offer strong parallel support for the screen frames they will hold. The floor is made of ¼ inch plywood on the picture frame base of 1 x 4 inch miter-corner fir or pine boards.

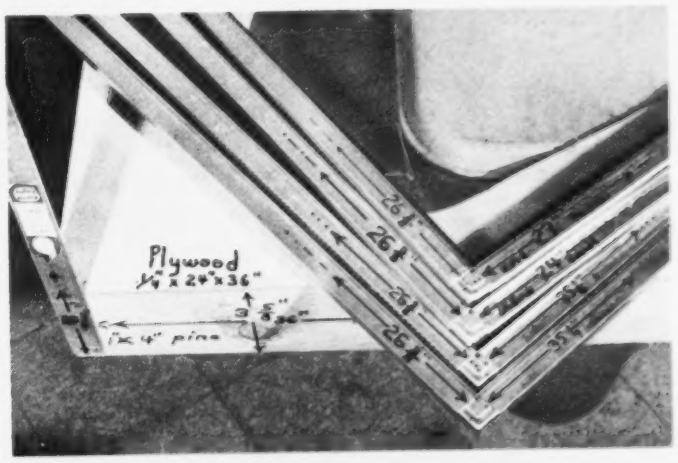
Before assembly, all holes for food and water dishes, sand trays, and potted plants should be cut and sanded down. One-quarter inch diameter holes should be drilled through the floor at approximately every six inches around the edges (just

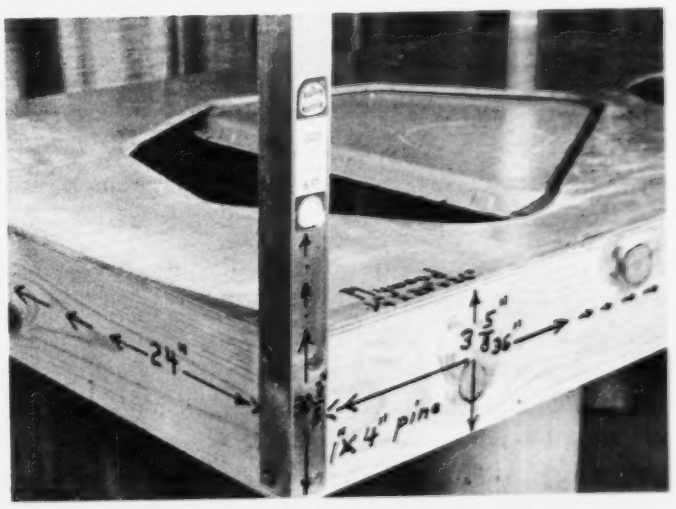
inside where the 1 x 4″ picture-frame base will be nailed and glued) to allow air to circulate. The picture-frame floor assembly is then put together, and treated with a water-proof, wood sealing finish. When dry, the angle-aluminum corner pieces should be drilled and counter-sunk to accommodate wood screws and then secured in place. A dab of clear silastic rubber should be spread along the joint to enhance the strength of each corner mounting. The angle-aluminum corner brackets can be as high as desired. Care should be taken to make sure each provides a parallel facing all the way around for the screen frames they must support, with additional length to accommodate the plywood top that caps the enclosure.

Screen frames are made from special strips of screen holding channel aluminum and corner assemblies of the kind sold at most hardware stores. While measurements are given in the illustrations shown here ⟶, these frames can be made to any size desired. Care must be taken that the final frame assembly is tight fitting, with special allowance for a sliding frame at one end. When measuring to cut the aluminum screen strips, allowance must be made for the added length of the corner fittings.

When assembling each of the four frames, their corners must be tight so they will not shift or yield to the pressures exerted by the stretched film they are to contain. For this purpose they may be crimped. Any spaces that remain should be filled with silastic rubber to make sure that the corner joints will stay firmly in place when the Surlyn film is mounted. Surlyn A "Blister pack" film is a DuPont plastic material. A call to the local DuPont office will provide information on a nearby source. The roll of film that is used should be at least four inches wider all way around than the frames in which it will be mounted.

The plastic film is mounted in each screen frame in the same manner that wire screen is mounted. The supplier can provide this information. In this case, however, the Surlyn film must be cut oversized, and then stretched out over the ready-for-mounting frame on a large table, to assure that it is taut and free of wrinkles. Pieces of masking tape may be used to pull it out until it is taut and wrinkle free.



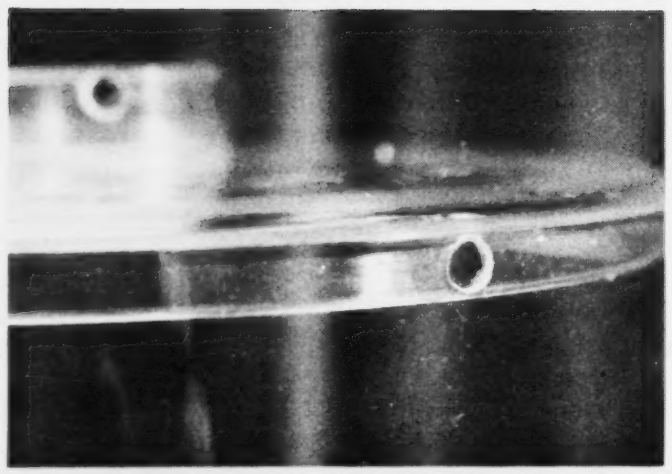


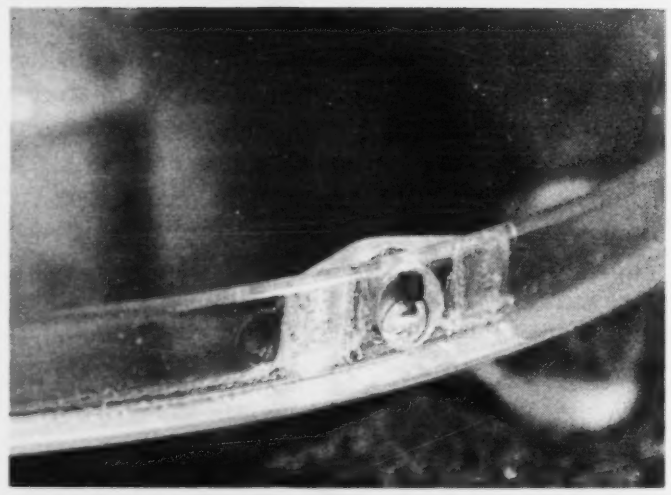
Special aluminum runners come with the screen frame aluminum and are pressed into slots in the runners to hold the film in place. Once cut, the ends of all aluminum strips should be smoothed free of sharp edges with emery paper before mounting the film. All four runners should be pushed into the four sides of the frame to hold the film into place. The Surlyn plastic will stretch a bit, but this is proper. When all runners are in place, a sharp knife can be used to trim excess plastic film.

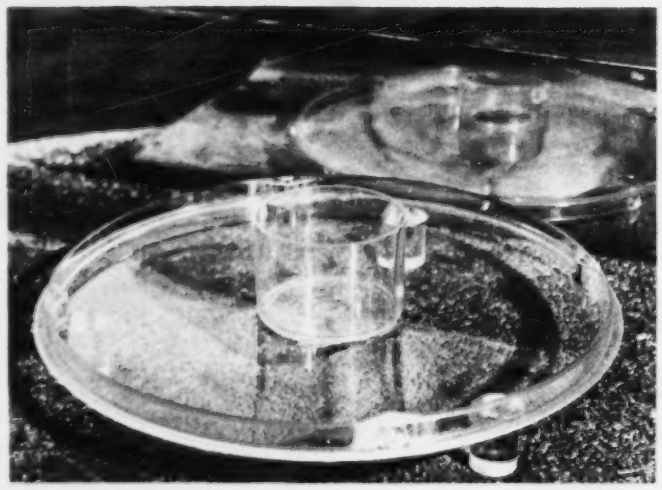
Black masking tape can be used to cover the hold-down runners and edges of the film. Any wrinkles in the stretched plastic film after it is mounted may be eliminated by allowing a stream of hot tap water to play on the film to "form" the film, clean it, and "set" it smoothly in the frame. When all four frames are completed, they are ready to be mounted in the aluminum brackets of the enclosure.

The plywood top should be fitted with small corner blocks on the underside that will serve to "home" the top in place and brace the tops of the screen frames, flush in place, against their angle-aluminum supports. The end of the top which is cut short (in order to allow the screen frame in that end to slide up with having removing the plywood cover) should be supported at that end with a strip of wood beneath the underside of this end. This will prevent the tendency of this end to sag due to lack of support.

A power cord must be provided for aquarium housing lights or other lighting fixtures of special design nested in the plywood top. Rather than extend this cord overhead to a remote socket, it is best to provide an outlet in the base of the enclosure. The light cord from the top can then be run down one angle-aluminum brace to plug into a socket mounted in the picture-frame base. Although this arrangement is not entirely necessary, it is neater than a dangling overhead cord. The aquarium hood lamp housings should be







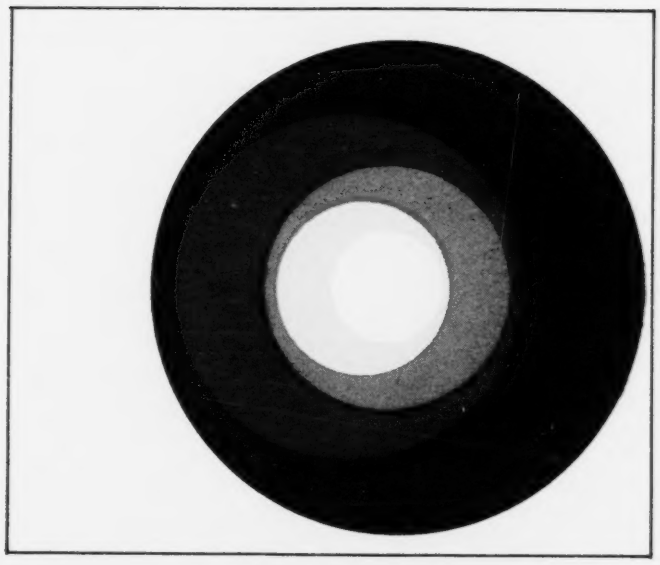
equipped with fluorescent plant-growth lamps for the benefit of the shrubs and other potted plants located in the enclosure.

The floor of the enclosure may be fitted with a natural-looking plastic carpeting (a hardware store item) cut so as to permit easy removal from around the recessed dishes when necessary for cleaning. A hand punch may be used to cut out air holes in the carpet to match up with those in the wood floor. It is well to provide two of these carpets, to be alternately used in the enclosure so each may be thoroughly cleaned and dried out from time to time.

This enclosure can be made as large or small as needed. The one shown **on page 7**, complete with measurements, is big enough to support the growth of a small shrub. Anoles—the American "chameleon"—quickly make this their arboreal home. It is also large enough to provide a home for a small iguana. A fiberglass restaurant serving tray containing dirt and gravel serves as a base for this shrub and several other smaller plants. The tray is recessed in a cut-out section of the enclosure floor, with the tree pot and other plant pots recessed through the bottom of the fiberglass serving tray. The enclosure shown is big enough to include even a small water pond—complete with water filter and a small "tensor" lamp basking light—to satisfy the needs of several small water turtles.

Though the film siding is quite tough, it may be punctured. If so, it can be patched with tape, or replaced from time to time with a new piece of plastic film. With reasonable care, however, it will last indefinitely.

The earthen tray will support a ground-covering plant growth which derives its energy from the overhead lamps. The addition of a few dryland hermit crabs will assist in keeping the enclosure clean. Anoles, many turtles, lizards, and snakes, all will thrive in the warm climate this inexpensive but environmentally-complete enclosure provides.



ENCLOSED ENVIRONMENTS FOR ANOLES AND OTHER WARM-CLIMATE WILDLIFE

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A simple yet suitable enclosure can be made of plastic materials commonly found in local stores. Although the enclosure may take any convenient shape, it is recommended that the basic design be a cylinder constructed of a single piece of clear actetate sheeting which nests between two similar-sized plastic container tops. Such acetate sheeting may be obtained from a drafting supply store, and should be at least .0075 inches thick—if possible, thicker than the weight used for covering desk blotters.

For the top and bottom of the cylinder the best container lids are those which have a lip, or recess, which will fit well in place when matched up with the ends of the acetate cylinder. The cylinder should be cut so as to neatly fit the circumference of the rims or slots in the lids. To form the cylinder, two edges of an acetate sheet will have to be joined together. When calculating the length and width of the cylinder sheet to fit the circumference of the container lid allowance should be made for an additional half-inch for an overlap. The edges of the acetate cylinder are secured together by using half inch transparent plastic tape that is adhesive on both sides. Two people should perform this step, since it takes more than two hands to hold the plastic sheet in place while the strip of tape is aligned along one edge, and then carefully overlapped so the edges are even when stuck together.

Bonding the overlapped edges of the cylinder may also be done using acetone as a solvent, instead of plastic tape. This will make a more permanent joint, and a neater one. Acetone can be brought in drug stores where it is often sold as "non-oily" nail polish remover.

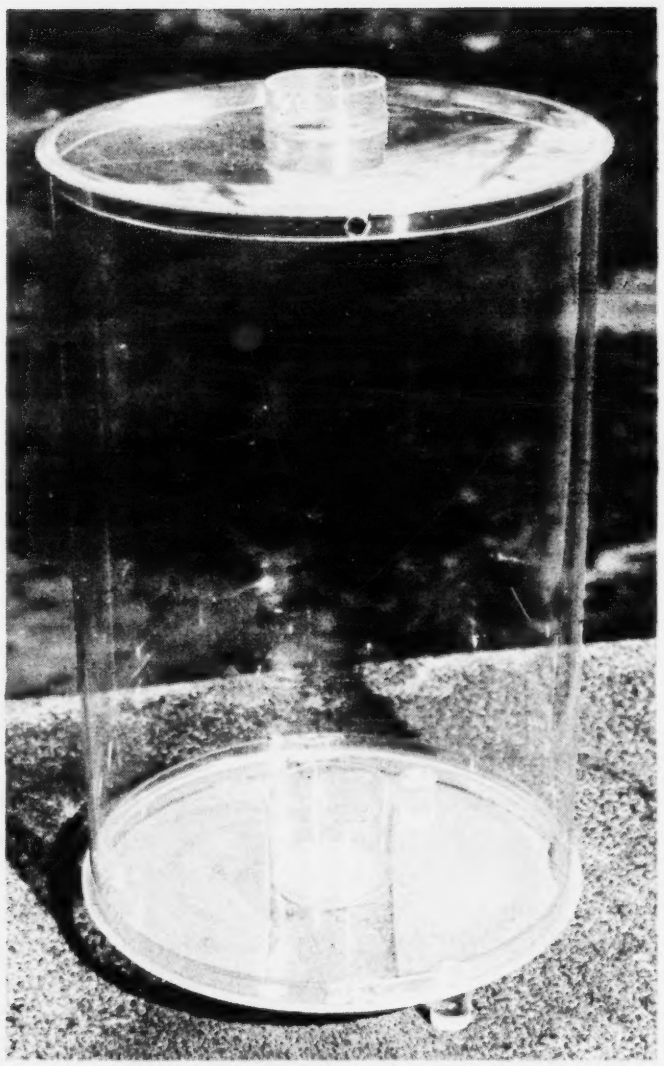
When the acetate cylinder is set in place, and nested between the two capping lids, the chamber will be virtually sealed. However, there must be a means for maintaining a flow of air through the enclosed chamber. To provide air input, use a hand punch to make 4 to 6 small holes at equal distances around the top and bottom edges of the cylinder. Locate these holes far enough in from the edges so as not to weaken the cylinder rims. If clear styrene plastic container lids with raised lips have been used, the holes in the acetate should be located so that they are centered against the raised lip. Their desired location on the lip should first be marked with a pin-scratch or marking pen. Then the holes can be carefully drilled in the ridged styrene plastic lips. Do this at the top and bottom. A speed-control drill is best for this step, as styrene flows if the drill bit gets hot. A slow turning bit will help prevent this.

This arrangement of air holes in the acetate will allow the cylinder to be rotated in order to either open or close these openings. Simple as this air flow arrangement appears, it will afford excellent control of the inside climate by regulating temperature and moisture content and the movement of air through the chamber.

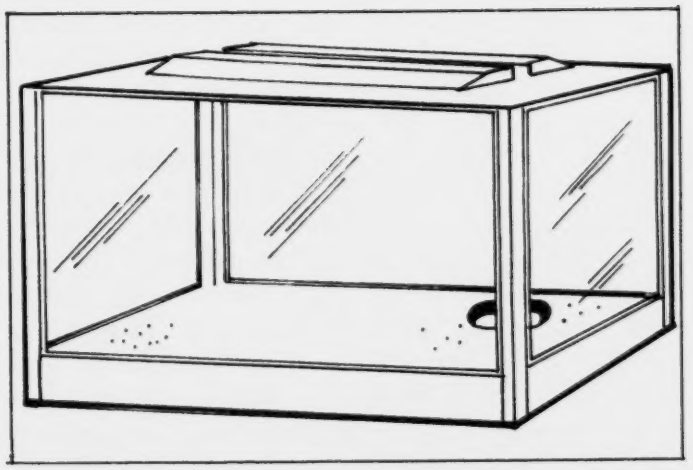
There must also be a means of access to the inside to occasionally add food and water. One way to do this is to remove the top cover when access is needed. An alternative to taking off the top cover is to cut a small round hole in the lid that serves as the top. This opening should be about ¾" in diameter over which a piece of screen or in which a plug can be put to keep the anoles from getting out. The Nylon Filter Corporation of Hebron, Illinois 60034, makes an ideal plastic screen cap-like closure (their part #NFC 33350) that snaps on and off for easy access to this opening. The base of this closure can be epoxy-cemented in place over the hole. The screened top portion of this cap can then be snapped on and off as needed for sprinkling water onto the plants inside, or dropping in meal worms to feed the animal life inside.

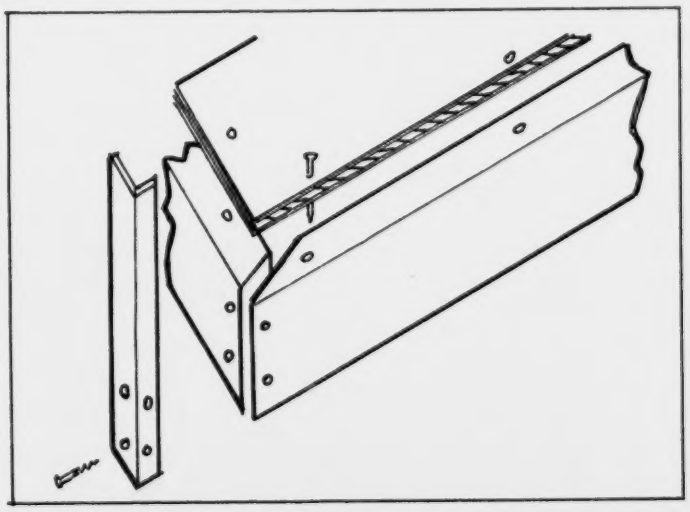
Cutting holes in styrene is difficult. A round-tipped soldering iron may be used for making small holes, with a little knife work to clean up

afterwards. Larger holes may be cut with a coping saw, but this must be done with great care since the coping saw tends to jam and fracture the styrene material. As an alternative method, a thumb-screw adjustable drafting compass makes a fine tool for "scribing" a hole out of styrene. Using the regular pivot pin for centering the compass, put a steel pin in the "pencil" end. By continually scribing or etching a circle in the styrene the point of the pin will cut neatly through the plastic. Doing this etching from opposite sides of the styrene will hasten the cutting process. No other technique of cutting large holes in styrene is as quick and effective.

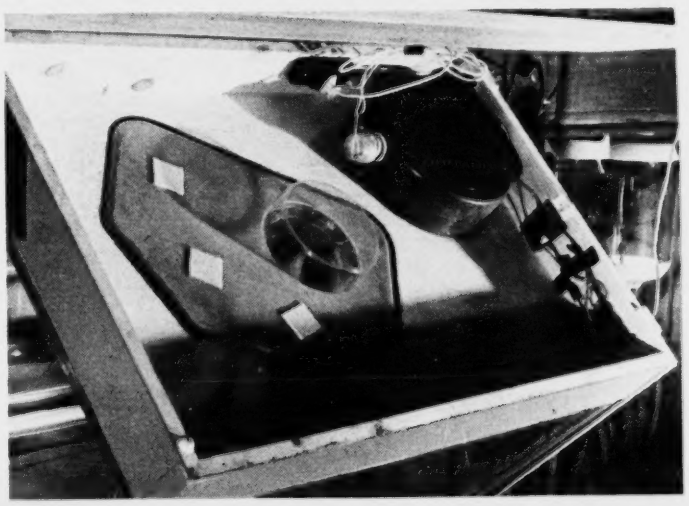


The inside "decor" of the cylinder enclosure can be made as sparse or as elaborate as desired. To make the system as self-supporting as possible, the floor should be sodded with rich humus and planted with clover or some slow-growing and low-ground cover. (A garden shop plant known as "Baby Tears" is an excellent choice.) When dirt is used, the air holes at the base of the cylinder wall should be kept free of dirt, using stones or small plastic window walls to insure free air flow through the holes. An attractive small shrub makes an ideal center plant for the container and provides place upon which the anoles can climb. When this is provided, they like to stretch out on the uppermost leaves of such plants. A small plastic pill box can be used as a pot in which to plant this shrub. The box can be epoxy-cemented in place on the floor of the cylinder to prevent its being tipped over. "Snopake" solvent also works to bond styrene parts together.

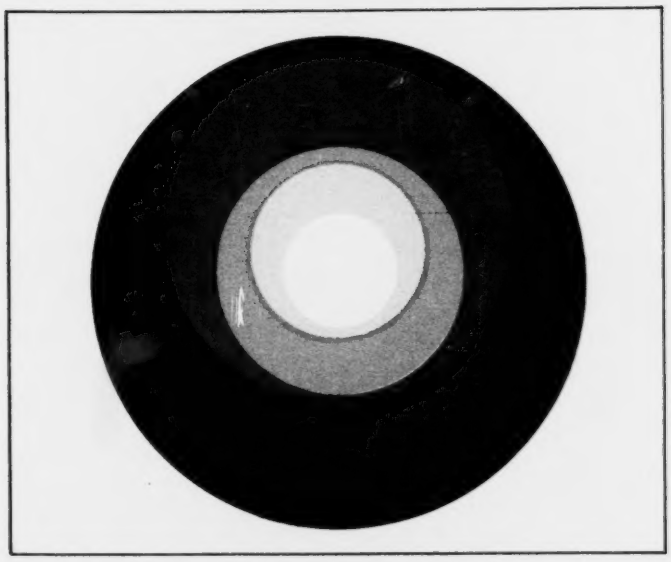




A plant-growth lamp, hung above the container, will provide both warmth which the anoles need as well as radiant energy for the plant life. This plant life plays an important role in maintaining the cleanliness of the enclosure. The droppings of the anoles will be absorbed by the soil which decomposes it in a natural manner. Consequently periodic cleaning will be virtually unnecessary. A dry-land hermit crab also may be added to aid in the housecleaning chores. It will feed on most anything left over from the feeding process, as well as matter that grows in the soil.



The net effect of this system is to create an attractive and almost completely self-sufficient assemblage of compatible plant and animal life—all housed in a low-cost, easily built container that affords both excellent visibility and controlled protection of the enclosed environment and the life it supports.



INDOOR TURTLE PONDS

Providing a healthy indoor environment for water turtles calls for clean, chill-free water, a warm place out of water where they can dry off, space in which to swim freely, and places to hide. While an aquarium may provide most of these features, turtles do not require deep water. They do better in shallow pond-shaped containers.

A choice of shallow containers may be made from many plastic pond-shaped items sold in local stores. These containers range in size from a child's shallow wading pool or baby bathing tub down to pet store cat-litter trays.

In addition, a very satisfactory aluminum angle-frame glass tank can be constructed in table-top size from easily obtained materials. Silastic rubber, found in most hardware stores, makes an excellent bonding agent to hold the glass tank together and make it water tight. Half-inch aluminum angle-strips from a hardware store are silastic-bonded over all joined edges of the glass to strengthen the tank and improve its appearance. Double-strength window glass is adequate to use for tanks no more than seven inches deep or more than two feet long on any side. The same window glass can be used for the bottom but must be reinforced with a half-inch thick plywood bottom. The edges of this bottom board should be chiseled out, a half inch in from the edge around the base, so that the aluminum angle edging that goes around the bottom of the glass tank will be recessed below the upper surface of the board. This done, the glass bottom will lie directly upon the board and receive full support from the plywood bottom.

The four glass sides and the bottom piece should be carefully cut to the size tank desired so they will fit squarely when they are cemented together. Emery paper should be used to dull any sharp edges of the glass that will be exposed. Gloves should be used when doing this to avoid cutting the hands.

Caulking the four glass sides together and in place on the bottom glass is best done by first taping all glass panels in place from the outside with masking tape. This will hold the glass together until all inner seams have been caulked with clear or black silastic rubber. These seams should be allowed to set over night. (Hardware stores are good sources of this material.)

Four ½-inch aluminum angle pieces should be cut as corner covering, as well as pieces to go around the four bottom edges of the tank. When the bottom pieces have been caulked along the glass joints with the silastic rubber, they should be mitered to effect a snug fit of all aluminum pieces. All pieces should be held in place with masking tape until the silastic adhesive is firmly set.

Keeping the pond water clean requires a special oil-collecting filter and a pump to pull the tank water through it. The diagram **on page 15** illustrates the basic design of such a filter. In operation, water flows in through the two slits near the top of the filter bottle made from a one-quart size plastic bottle or container. The water is pulled through a piece of plastic sponge material (do not use cellulose sponges) and the rocks below it by a pump attached to the ½ inch aquarium store vinyl tube coming out of the bottom of the tank. The slits in the bottle should be located at the tank's water level, and should be narrow enough that inflowing water cascades downwards. This cascading effect causes the surface oils, produced by food and waste matter, to collect in the filter sponges. A rock cap holds the filter in place on the bottom of the tank. If desired, the filter may be cemented in place with silastic rubber to avoid tip-over problems.

This rock cap can serve as a basking area. Also, it may be extended by cementing additional pieces of rock on the under edge of the main cap rock with silastic rubber or epoxy cement. Rocks must be thoroughly cleaned before being

cemented together, and "C" clamps may be needed to hold the rock pieces together until the cement sets overnight. When the assembly is complete, it should be designed in such a way that it can be balanced on the filter bottle.

Selection of a pump must be based on the amount of tank water involved. For a large 200 gallon wading pool—and lots of turtles—a pump moving 300 to 500 gallons of water per hour is called for, and a filter made in a gallon size plastic bottle or container (about six inches across).

Selection of the type of pump needed deserves careful study. Those in which water movement is handled with both input and output tubes are best, since water must be pulled through the filter and it is desirable to connect the pump input directly to the filter's output tube. Many garden supply stores sell small submersible fountain pumps. Some of these can be mounted in the side wall of the filter box, thus eliminating the filter output tube. Others can be mounted in the side of the tank, or on an over-hanging bracket at the pool's rim.

In larger tanks, such as those made from large wading pools and placed on the floor, a separate basking ramp or log can be used, and the filter may be held in place elsewhere in the tank under a single slab of rock.

A trim slice from a large log—a scrap item at most saw mills—will afford a natural looking bark surface upon which turtles can climb to get out of the water. The wood underside can be drilled to take ½ inch dowel legs; each tipped with rubber chair leg tips to avoid puncturing the tank bottom when it's set in place in the tank.

A basking light should be located above the ramp upon which the turtles can climb to get warm and dry. A 150-watt reflector bulb, at two feet or more distance, provides adequate warmth.

In cooler climates or where room temperatures seldom exceed 70° F, a good thermostat-controlled aquarium heater should be used to hold tank water between 75-80° F. It can be firmly mounted on a side bracket of wood or aluminum so it extends almost to the bottom of the tank, in the water.

In smaller table-top tanks, small aquarium heaters should be used if the tank's water temperature fails to hold to above 75° F. Where submersible pumps are used, they may impart enough heat into the water to warm it adequately.

Aquarium gravel, no more than a half inch deep, should be spread on bottom of the tank to give a more natural appearance. Small rocks also add to this effect, but care should be taken to see that they do not puncture a plastic tank or break the bottom of a glass tank.

Where only a few turtles are placed in the tanks, water plants can be added where they can have the benefit of plant-growing fluorescent lamps. Where many turtles are involved, it may be desirable to use plastic plants from an aquarium store. Most turtles include plant life in their diet, and so they will feed on any living plants available to them.

The addition of a few bottom-feeding turtles, such as infant snappers, musk and mud turtles, and several plecostamus catfish from an aquarium store will greatly aid in keeping the pond clean. These species pick up food overlooked by the other turtles, and add to the overall activity in the pond.

Turtles like variety in their diet, including an occasional piece of fish and a sampling of grocery store greens. Since a filtering system is used, they can be fed on the water of their tank. A good staple diet should be used. One example of a suitable diet is the dry fish hatchery pelletized food known as "Trout Chow" #5105 (a Ralston Purina product). It is inexpensive and does not

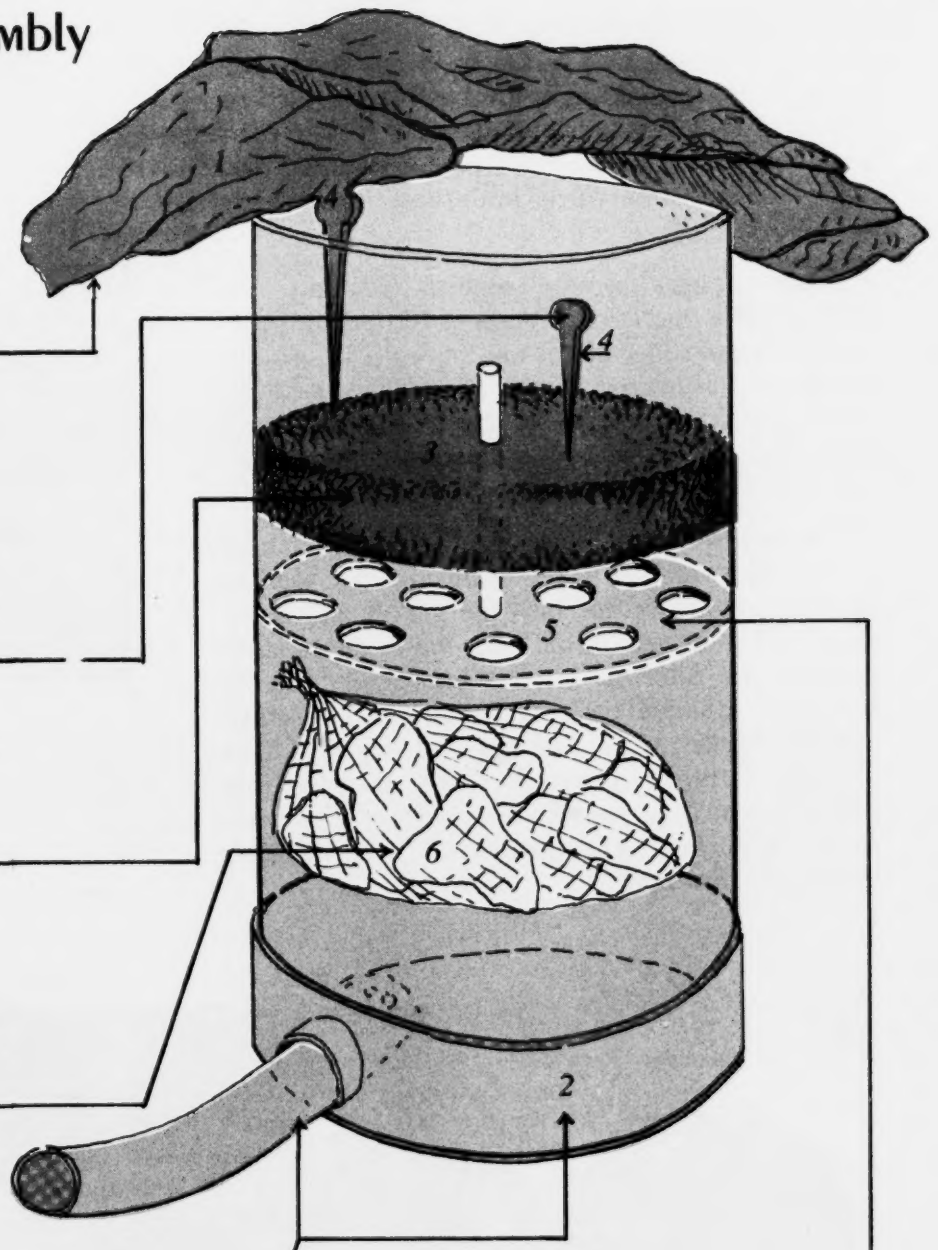
filter and rock ramp assembly

1.
Several flat rocks are epoxy or Silastic-rubber cemented together to form a well-balanced cap rock. At least one piece of rock must be cemented at an angle, to reach down in the water so that turtles can climb out on the cap rock.

4.
Two slits in the bottle allow water—and surface oils—to flow into the filter; cascading downwards to about a three-quarters of an inch lower water level inside the filter. Depth of tank, . therefore, is from the filter bottom up to almost the top of the slits.

3.
Polyethylene or similar plastic sponge material is used for the filter. When water no longer 'cascades' downwards in the filter, it must be cleaned.

6.
Small course construction gravel supports the aerobic bacteria culture that helps clean the water. Net plastic grape bag helps lifting the gravel out for cold-water rinsing.



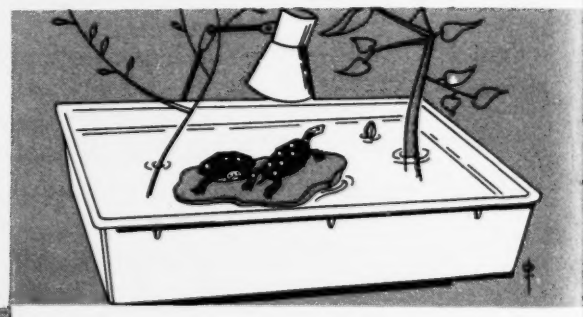
2. & 7.
Filter container can be an old plastic quart bottle. Hose at the bottom should be selected to fit the input of the pump chosen to power the filter.

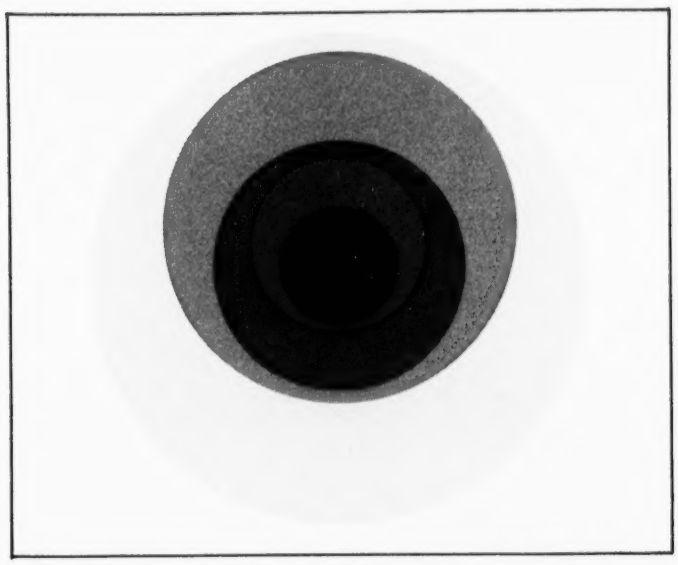
Circular plastic lift platform isn't required, but it makes filter removal much easier. (5)

require refrigeration. Some aquarium stores will stock it, on order; and generally it can be bought in large bags from agricultural feed stores. A large bag will last indefinitely, and, being very economical, some waste can be tolerated if one cannot find another turtle enthusiast with whom to share it.

Filter sponges require regular cleaning. To facilitate this operation, obtain polyethylene plastic sponge sheeting, about one inch thick, usually found in hardware stores. Several snug-fitting pieces should be cut to fit the filter bottle, and their use can be rotated so each is allowed to dry out after washing every so often.

The coarse-finish gravel pile in the filter also plays a vital role in water cleansing. An aerobic bacteria culture settles into the gravel and helps process the wastes from the water circulating through the filter. If only a few turtles are in the tank, a single bath of water will stay clean several weeks, with daily or half-weekly filter changes. Turtles can carry intestinal disorders that affect humans, so care should be taken to wash hands well after cleaning filters and handling articles in the tank.





ARENAS FOR TURTLES WITH MICROCLIMATE CHAMBER

Certain types of wilflife such as turtles and lizards, need variety in the climate of their habitat. In the outdoor environment, nature offers this variety by providing rocky ledges, high and dry and exposed to the sun, and also providing fallen logs, moss-covered, damp, and shaded. When this is its natural environment, wildlife moves at will from one microclimate to another. If this same wildlife is moved indoors, its need for environmental variety can be met by providing separate enclosed chambers in which temperature, humidity, light and shade are controlled.

For use in a classroom or other indoor display area, simple enclosures for non-climbing reptiles can be made with low glass sides, using a picture-frame base that serves both as the floor of the arena and as a place to mount the angle-aluminum corner posts that hold the glass siding. Within the arena, the space is divided among two chambers. One is open to the air and temperature of the room—a man-made environment. The other chamber is enclosed, with a watering dish furnishing a moisture source, and a high-intensity outside lamp furnishing warmth and light within the chamber.

Easy access to the enclosed chamber is important. Open doorways are not practical if the warm, humid atmosphere of the chamber is to be maintained. To provide a sufficiently closed space and, at the same time, allow animals to enter and leave at will, a strip of clear mylar plastic sheeting may be hung from the glass or plastic top panel of the enclosed portion of the arena. This mylar curtain hangs almost to the floor of the arena, and has a series of vertical slits cut at intervals of about an inch apart. The animals thus are able to push through the slit curtain with ease whenever they wish to enter or leave the chamber. As they push through the curtain, it falls back into place, closing the chamber again.

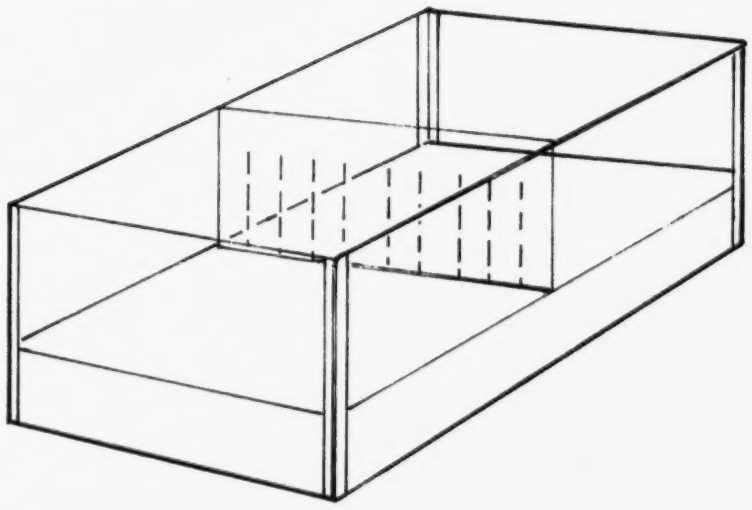
The task of fitting and hanging the plastic curtain will be helped by first making a crease along the edge of the curtain which is matched with the roof of the enclosure. This will create a right-angle lip which can be taped to the edge of the top panel. Scotch tape that has adhesive on both sides works well for this purpose, and is available in most drafting and art supply stores.

Standard double-strength window glass can be cut for use as the arena sides and the cover panel of the enclosed chamber. The exposed edges of the glass panels should be dulled with sandpaper, and gloves should be worn while working with freshly-cut glass.

Construction of this arena starts with preparing the plywood floor, and cutting holes in it for placing water dishes or other fixtures. At this time, it also may be desirable to cut and lay down pieces of plastic carpeting for the arena floor. A wide variety of textures and colors for such carpeting is available at large hardware stores. Where feasible, several carpets should be prepared, so they can be rotated—one in use, with others are washed and thoroughly dried.

At each corner of the plywood floor-platform an aluminum angle bracket should be fastened, extending upward as high as needed to hold the side and end panels in place. Although the glass panels will be cut to fit snuggly into the frame provided by the brackets, it is well to tape them into the frame, using cloth masking tape with adhesive on both sides. It is suggested that the panel at the end opposite the enclosed chamber be left without this adhesive tape, so it will be free to slide up and out of the bracket to allow access for cleaning the floor of the arena. Figures show how to prepare and mount the glass panels in this manner.

A reflector bulb of about 75 watts should be mounted over the glass cover so that its heat radiates into the enclosed chamber. The water dish, which can be made from half of any ball-hinged plastic box, should be recessed into the floor below the light so it will receive the

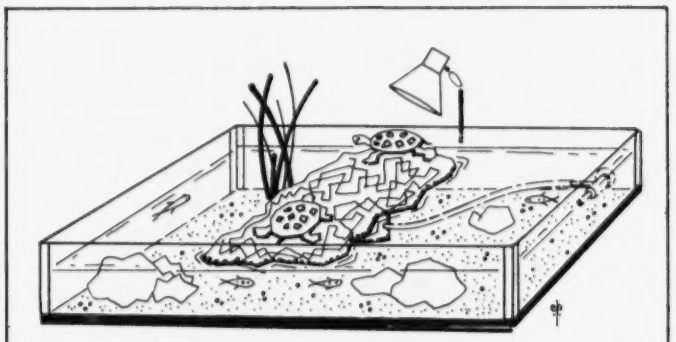


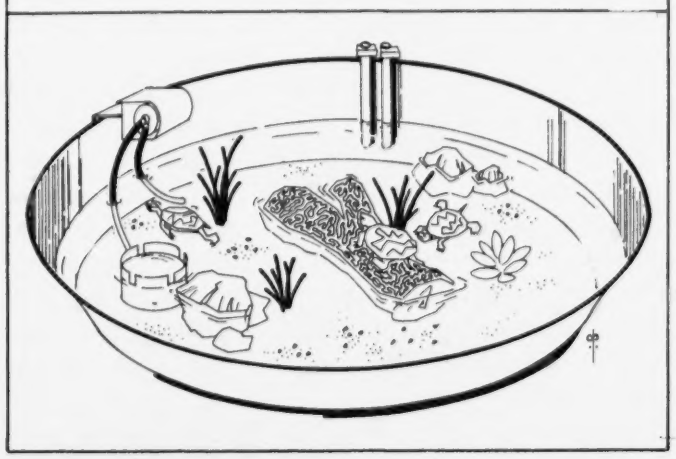
radiation from the lamp and evaporate water vapor into the atmosphere of the enclosed chamber. The bail-hinge and snap closure lips of the plastic dish serve to keep it from falling through the hole in the floor in which it sits. A black dish is best, as it traps more heat, and thus increases natural evaporation. A thermometer can be used to monitor the temperature inside the enclosed chamber, and the lamp should be placed at a distance above the chamber top which assures that the temperature inside will hold at about 75-80°F.

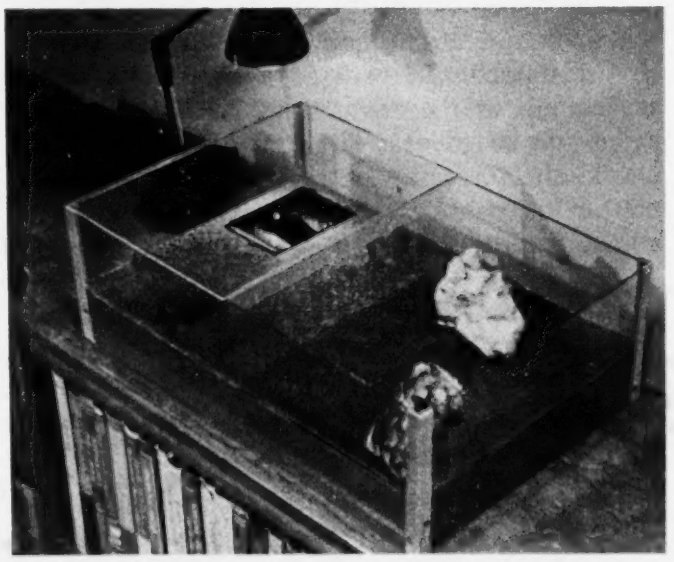
The net effect of this design is to provide areas where the animal life inside the arena can have a choice between a warm and humid climate or a cooler and drier climate, each of which is important for its health and comfort. Small pieces of bark or carefully-piled stones may be placed in the arena to provide places of seclusion. Small potted plants serve the same purpose, as well as enhancing the natural appearance of the arena.

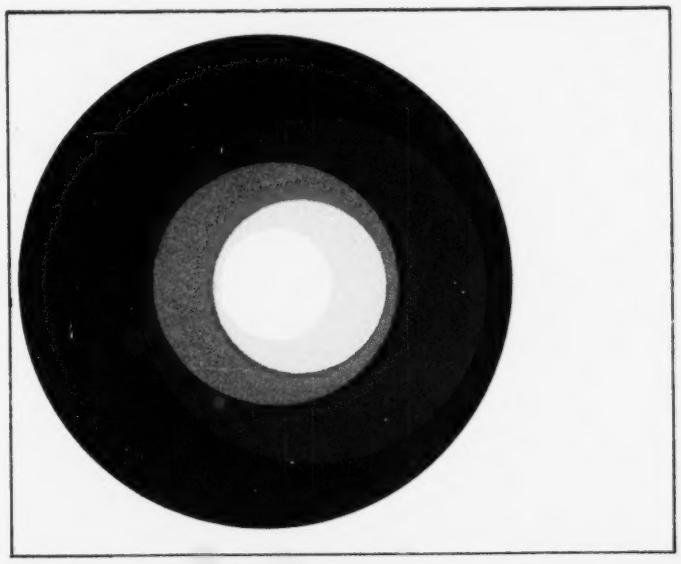
When the arena is built and stocked with animal and plantlife, it should be kept clean by sweeping out the floor each day, and regularly changing or washing the plastic floor mat. A dry-land hermit crab from a pet shop will also serve as an excellent housekeeper for the arena, since it picks up bits of dropped food and gets along well with most other types of animal life sharing its quarters.

It is important to wash hands thoroughly after handling turtles, lizards and similar animals, and after cleaning the arena, since these animals can be carriers of certain infectious intestinal disorders that affect humans. By washing hands after working with the arena and its inhabitants, these disorders can effectively be avoided.









"WORLD-UNDER-A-DOME"—MICRO-CLIMATE ENCLOSURES FOR PLANTLIFE

Many small plants, including mosses, which grow on the forest floor will thrive in the home or class room, provided their humid climate is brought indoors with them. Placed in an enclosure, with a source of incidental light for energy, and occasional mist-watering with an atomizer or spray bottle to replace moisture loss when the enclosure is opened, this display presents a complete life support system. Such a "world-under-a-dome" can become an attractive, constantly-changing, educational exhibit of forest floor plantlife.

Containers to enclose these exhibits are available in a wide variety of sizes and shapes. They range from large hemispherical domes-on-trays and cake covers, down to an inverted plastic drinking tumbler. Designs and dimensions may be selected to fit space available. Units may be designed to include their own specific plant-growing fluorescent tube. (Figure 11). Others can thrive on light from a window, or a medium-intensity overhead tungsten lamp. (Figure 1). The larger units may be constructed to set upon a "Lazy Susan" turntable, and rotated from time to time to make sure all sides are evenly exposed to their light source. (Figure 5).

The plants which are best adaptable to this enclosed environment come from the forest floor —mosses, small ferns, partridge berries, lichens, and rattlesnake plantain. Many mosses, even those that grow in the cracks of city sidewalks, may be included.

Within their enclosure, the plants should be arranged so they will look natural and efficiently occupy the space.

The illustrations (Figure 2) show raised or "tiered" gardens made of natural-looking stone-edged shelving. Stone frames for the "domed" gardens are fashioned from slabs of thin rock stacked in such a way as to provide ledges into which the plant materials can be tucked. After being thoroughly cleaned, the stones are cemented together with epoxy cement or with silastic rubber, to form a single unit.

In the case of the cylindrical lump, (Figure 3) the elevated ledges are fashioned with plastic spools, cups, and circular pieces of plastic. All are then cemented together to form a basic sculptured frame. On this frame, small wedges of thin stone are cemented in place with epoxy or silastic-rubber to complete the shelving. When plant material is tucked in place, only the natural-looking rock material will be left exposed.

In the very small units, empty Scotch tape spools, parts of pill vials, and other small plastic scrap are used as separators for single pieces of small circular slabs of stone on which small pieces of plant material are placed.

When the basic structure has been built, mosses, and other plants can be put into place. Banks of mosses may be cut to fit the particular configurations which each level of the ledges offer, and small plants or ferns can be placed in with the various mosses. A portion of each plant's original earth should be retained with it. Locating the plants provides an opportunity for developing original designs for the layout of the micro-climate enclosure. Be selective in what plant goes where. Seek to make the enclosed display look attractive from all sides.

Once built, the garden should be sprayed lightly with water. Only the roots of ferns and other leaf plants should be heavily watered. When this is done, and the dome is replaced, nature's water cycle will operate in the same way it does in the outdoor environment.

In the case of a cylindrical enclosure which is fitted with its own lamp, a tube of acetate serves to confine the atmosphere surrounding the plantlife. This may be fashioned easily from a sheet of .0075″ acetate obtained from an art or drafting supply store. The acetate should overlap, and

should be taped together with scotch tape that is adhesive on both sides, or "bonded" together using acetate—known as "non-oily nail polish remover." These adhesives are generally obtainable in drug stores.

Since forest floor plants grow best in a moist atmosphere, condensation on the inner walls of the dome is an indication that the environment is adequately humid. Where necessary—such as during classroom instruction periods—this condensation can be wiped from the inside surface of the dome or enclosure with an "anti-windshield-fogging" cloth obtainable at auto supply stores. As an alternative, holes may be punched in the acetate wall of the cylinder to permit a little air flow through the inside. These "breaks" in the integrity of the system, however, mean that some moisture will be lost from the enclosed area. Thus, the more air permitted to flow through the system, the more attention will have to be paid to furnishing additional moisture for the system by occasional spraying.

The "world under a dome" is a living environment, and constantly changes. Plants will continue to grow, some touching the dome's surface. Cuttings from many such plants will re-root simply by tucking them back into a moss bank. Mosses and plants brought in during the late fall will often include the eggs of insects that will soon hatch in the "spring" temperature of the warm classroom. They offer novelty and illustrate the interdependence of plantlife and insects in the seasonal cycle of the natural world.

Since light is particularly important to enclosed plantlife systems, care must be taken to see that enough of the right kind of light is available. The domed worlds that are almost entirely sealed will do well in a window, but should not be exposed to direct sunlight for more than a few minutes at a time. Inside temperatures will rise quickly, and make the environment too hot for mosses that seldom grow in the bright light. Incident window light is sufficient, provided the "world" is rotated on its lazy susan table from time to time each day.

Artificial light may also be used. Both tungsten light and special plant growth fluorescent tubes are sufficient to nurture plant growth. Not all plants thrive on the same wave lengths of light, however, and so a mixture or choice among lamp types may be desirable. Many lamp manufactures provide literature on the plant-growing ability of their lamps. In addition, several books are available that deal with growing plants by artificial light. Several lamp manufacturers now market both lamps and special fixtures intended for use by the home indoor gardening enthusiast. Contact with the local agents of major makers of such equipment will bring information on the latest developments in this new approach to indoor gardening.

DEPARTMENT OF THE INTERIOR

Bureau of Outdoor Recreation

ACKNOWLEDGMENTS—

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Figures 1-6 are on this page. Figures 7-11 are on the back cover.

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